Measuring pH in Bacterial Oxidation of Metal Ores

BACKGROUND

Some gold ore deposits can be processed by simple grinding, followed by extraction with cyanide, but many refractory deposits contain gold that cannot be so easily separated. The most common example of these ores contains sulfides, the reduced form of sulfur. A powerful technique for exploiting such low-grade ore is called bacterial oxidation. With the help of sulfur-loving bacteria, the ore can be chemically oxidized, thereby breaking up the matrix holding the gold in solution. Gold deposits with as little as 1 ppm can be economically processed in this manner. This technique is also used to process nickel, copper, and cobalt deposits.

PROCESS OVERVIEW

Traditionally, low-grade ore has been roasted to convert sulfide forms to an oxide that allows the extractive chemicals (cyanide, for example) to penetrate the ore body. The main problem with the roasting technique is that the resulting odors are environmentally unacceptable. An alternative procedure for breaking up the sulfide compounds has recently become popular, bacterial oxidation.

The bacterial oxidation process is relatively slow and can be conducted in a heap leach or stirred reactor, with multiple tanks being very common. In general, bacteria such as thiobacillus ferrooxidans or Leptospirillium ferrooxidans are used at pH values of around 2.0. Temperature and pH are controlled to provide optimum growing conditions and oxygen is supplied to facilitate the oxidation process. The bacteria oxidize the metal sulfides into metal sulfates and sulfuric acid, but can also liberate arsenic (when present) in the form of arsenic acid. Arsenic must be removed in a second treatment tank in a co-precipitation process with iron that is favored at higher pH levels. This two step process both removes a good deal of the raw ore (concentrates) and improves downstream recovery considerably. After several days of residence time, the treated ore is ready to be efficiently processed by techniques such as cyanide oxidation. See Application Data Sheet #3300-08 for more information on cyanide leaching.

THE MEASUREMENTS

The bacteria that oxidize the pyritic (sulfur-containing) ore are relatively hardy in that they survive well in substantial amounts of heavy metals like iron, zinc, and nickel. Left to their own devices, however, they will use up the available dissolved oxygen and will drive the pH down below 2, which is the optimum growth value. Online control of pH using caustic or lime addition will keep the bacteria healthy.

The neutralization tank is used to raise the pH from around 2 to near 7 using lime. The lime combines with the process to form insoluble calcium sulfate, iron arsenate, and iron hydroxide. Online measurement of pH here helps contain the arsenic in a solid form that can be disposed of safely without overfeeding lime.

Measuring pH with an inline sensor is complicated by the nature of the process solution here. The solution, of course, contains ore, which can abrade the glass measurement electrodes and form a coating on the sensor. Lime (CaO) is frequently used for pH control; however, it has low solubility and can form a hard coating on the pH sensor, effectively taking the sensor out of service. In addition, bacterial action is designed to liberate sulfur compounds that can, over time, penetrate the pH sensor and contaminate the reference, causing large errors. The recommended pH sensor for this application must be rugged enough to withstand abrasion, resistant to attack by sulfide, and also resistant to coating. The TUpH® design is an excellent choice for this environment.

INSTRUMENTATION

The TUpH sensor is specially designed with a high area reference to combat the effects of coating. The reference junction is composed of ultra-porous glass-filled polypropylene that continues to function in processes with high solids. Inside the reference junction is a long helical pathway that protects that reference from attack by poisoning ions such as cyanide.

TUpH Model 396P has forward- and reverse-facing threads for mounting versatility. The Model 396P with flat glass (option -71) can be used in flow-through installations to provide self-cleaning action as the process flows across the sensor. For measurements inside tanks, the standard hemi bulb is recommended with the shrouded tip. For extra resistance to coating, a jet spray cleaner accessory is available as PN 12707-00.

The multiparameter model 1056 analyzer is ideal for monitoring the pH of the bacterial oxidation system. Standard features such as two 4-20 mA outputs, 3 process alarms, complete pH sensor diagnostics, and optional HART communication allow for convenient local control or distributed control with a minimum of unnecessary maintenance. A timer relay is included for periodic activation of a cleaning cycle. The Model 1056 can monitor two pH sensors simultaneously, reducing capital costs and panel space requirements.

JET SPRAY CLEANER on TUpH 396P

MODEL 1056

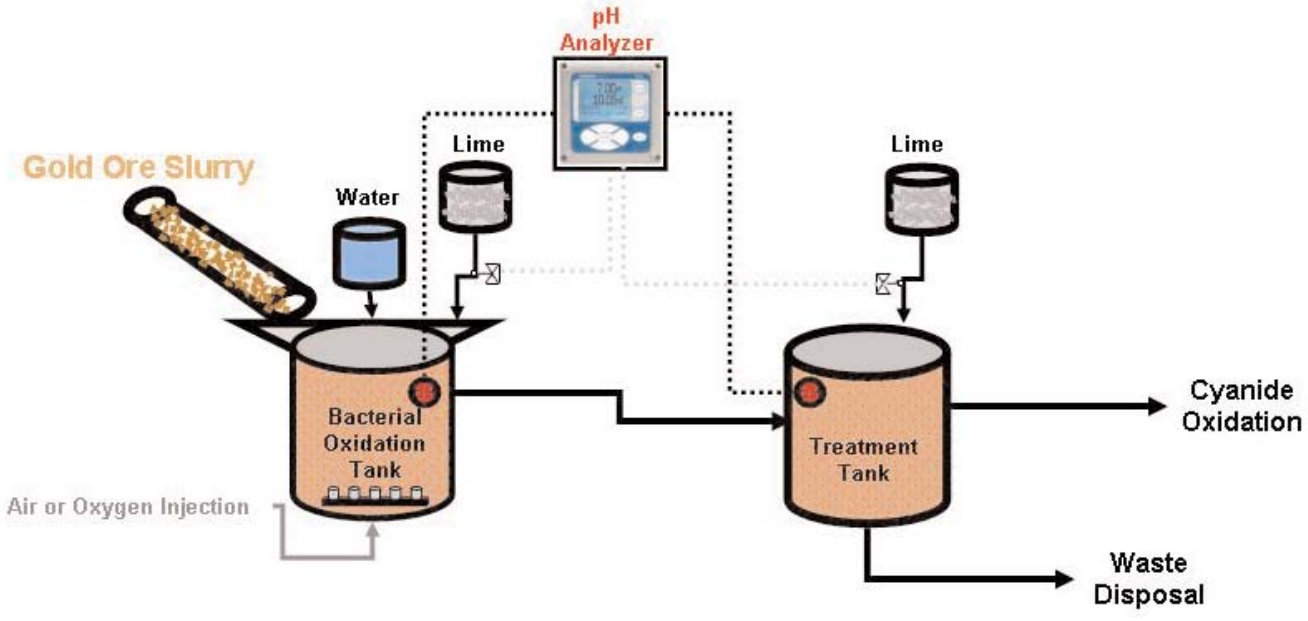

FIGURE 1. Bacterial Oxidation

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